Weather Note

HEAVY RAINS IN SOUTHEASTERN NEW MEXICO AND SOUTHWESTERN TEXAS, AUGUST 21–23, 1966

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ABSTRACT

Record-breaking rains occurred in southeastern New Mexico and southwestern Texas August 21–23, 1966, causing extensive flooding and property damage. The synoptic situation associated with this storm is analyzed and some of the possible factors contributing to the heavy precipitation are discussed. Time sections of the stratospheric circulation over White Sands Missile Range are presented which indicate that a sharp break in the westward zonal flow near the stratopause occurred just prior to the onset of the heaviest rainfall. Concurrent with this was a lowering and cooling of the tropopause.

1. INTRODUCTION

Following rains of almost unprecedented proportions, one of the most devastating floods in the history of southwestern Texas and southeastern New Mexico forced hundreds from their homes on August 22–23, 1966, destroyed large areas of rich farm and ranch land, washed out major roads and bridges, and isolated some communities. Several lives were lost, and damage estimates ranged into millions of dollars.

An isohyetal map of the heavy rains of August 21–23 is shown in figure 1. The portion in New Mexico was copied from an isohyetal map prepared by the U.S. Army Corps of Engineers, Albuquerque, N. Mex. from the results of bucket surveys conducted in that area. The Texas portion was developed mainly from cooperative observer reports, except in the Dell City area where a bucket survey was conducted by the U.S. Weather Bureau. Hence considerably more detail is shown in the northern portion of the heavy rain area than in the southern part.

The total rainfall ranged up to 17 in. in some of the mountainous areas of southeastern New Mexico where pronounced orographic factors were involved. The heaviest falls were recorded during the day and night of August 22. One rancher located about 50 mi. east of El Paso, Tex. reported that 8.5 in. fell in a 4-hr. period that night. Based on information contained in a study by the U.S. Weather Bureau [1], rain in that area of such duration and intensity would have a return period of well over 100 yr.

Some of the maximum reported rainfall rates and their locations are listed in table 1. No recording-gage information was available in the storm area, but some individuals, having gone out to read their gages several times during the heavy falls on the night of August 22, kept quite detailed records.

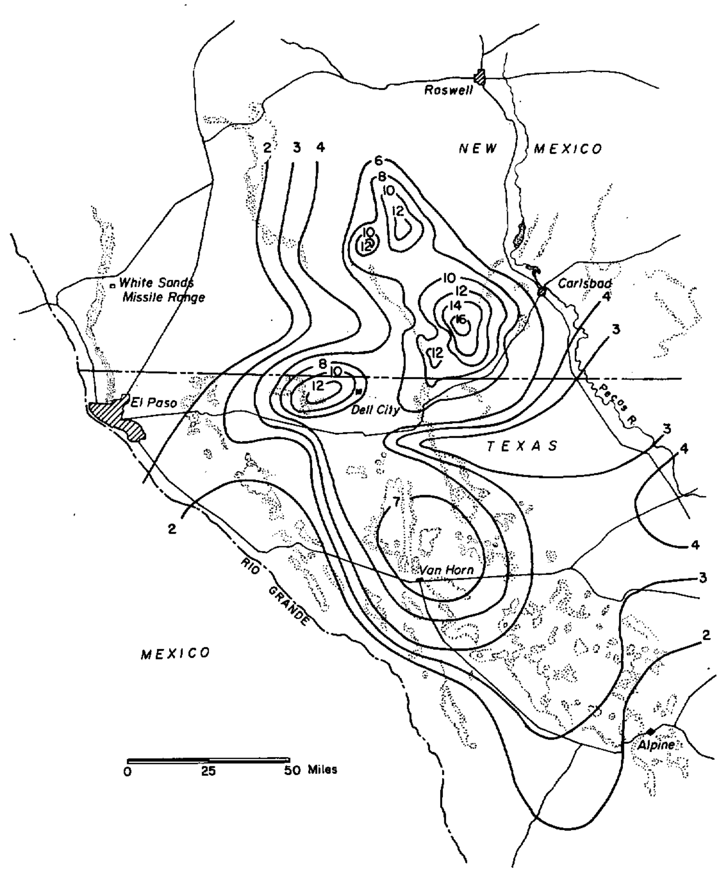

FIGURE 1.—Isohyetal map (inches), August 21–23, 1966.

TABLE 1.—*Maximum reported rainfall rates*

Location	Amount (in.)	Duration (hr.)	Rate (in./hr.)
50 mi. E of El Paso, Tex.	8.5	4	2.1
14 mi. WNW of Dell City, Tex.	10.0	10	1.0
6 mi. WNW of Dell City, Tex.	11.0	12	0.9
6½ mi. NW of Dell City, Tex.	8.4	12	0.7

2. SYNOPTIC SITUATION

Normally, during the month of August, the prevailing wind flow reaching southeastern New Mexico and southwestern Texas has its origin over the western Gulf of Mexico [2]. This moisture-laden current is the source of supply for the widely scattered thundershowers which are usually in evidence during the afternoons and evenings. The situation existing prior to the heavy rains was typical in this respect. A sluggish moist air mass prevailed over the area. Scattered showers had been occurring, mostly in the afternoons and at night.

Satellite photographs for August 20 show a band of cloudiness extending from the western Gulf of Mexico northwestward across Mexico into southwestern Texas and southern New Mexico. An area of cloudiness was also evident just off the west coast of Mexico at about 18°N. By August 21, this cloud area along the west coast of Mexico had moved to about 21°N. The cloud pattern existing over Mexico and the southwestern United States shows evidence of the development of a confluent flow, from the Pacific and from the Gulf of Mexico, which extended northward across southwestern Texas and southeastern New Mexico. On the morning of August 22, the area of cloudiness in the Pacific had moved to the lower Gulf of California with the cloud configuration suggesting cyclonic rotation (fig. 2). Clearly visible is the cloud band extending northeastward across the area of heavy rains.

A slow-moving cold front, which had entered the Texas Panhandle and northern New Mexico on August 20, was located along a line from Amarillo to just south of Roswell and northwestward to Albuquerque at 0500 MST, August 21 (fig. 3). The 6-in. isohyet has been sketched (dotted line) on this and the maps that follow to show the location of the storm area or area of heavy rains. By 0500 MST on the 22d, the front had pushed southward and eastward to a position near Dallas, San Angelo, and Dell City, Tex. (fig. 4) with the portion across New Mexico moving very slowly westward. The slow southward movement of the front continued during the following 24 hr. with its western portion moving close to the Continental Divide in western New Mexico (fig. 5).

At 1700 MST on the 22d, a moderately unstable air mass with a high moisture content lay to the south of the cold front (fig. 6). Surface dew points were generally in the lower and middle 60's (°F.).

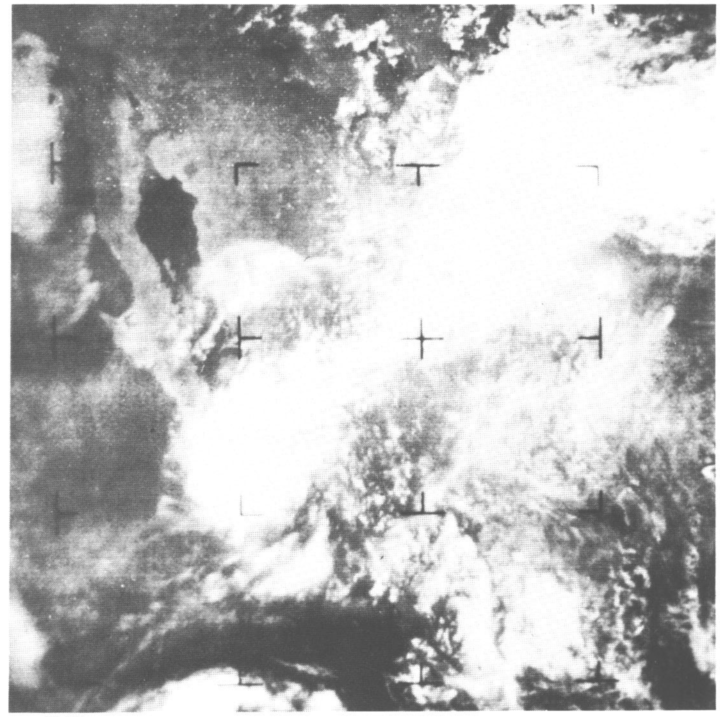

FIGURE 2.—Satellite photograph, Nimbus 2, Pass 1324–3 August 22, 1966, 1116:05 MST.

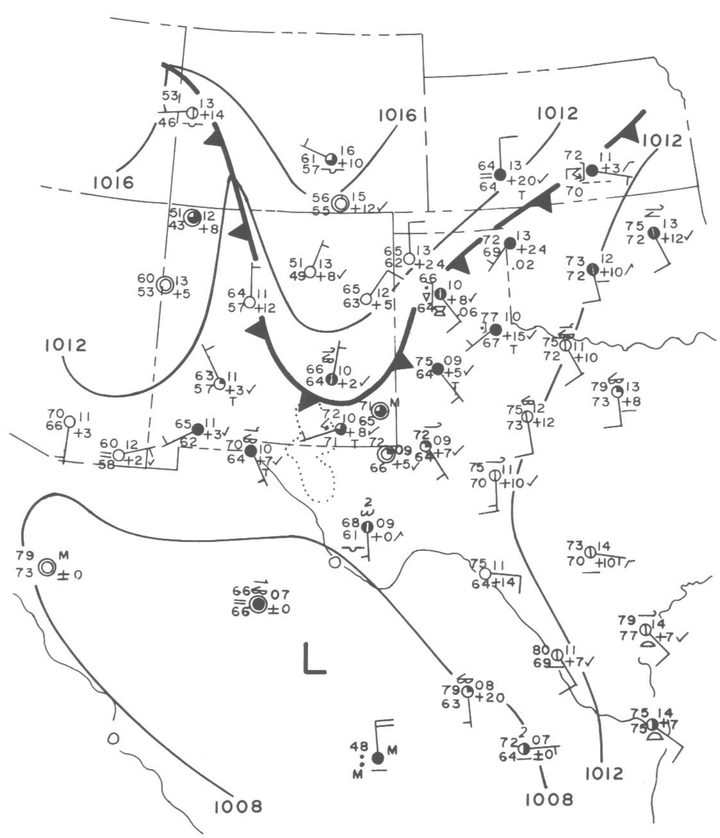

FIGURE 3.—Synoptic surface map for 0500 MST, August 21, 1966. Dotted line (the 6-in. isohyet) encircles the storm area.

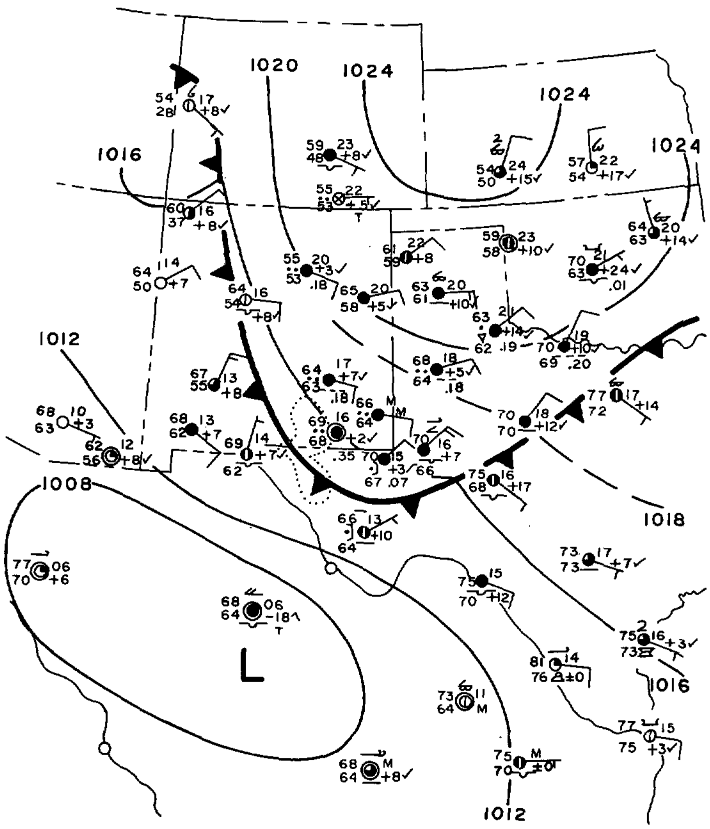

FIGURE 4.—Synoptic surface map for 0500 MST, August 22, 1966. Dotted line encircles storm area.

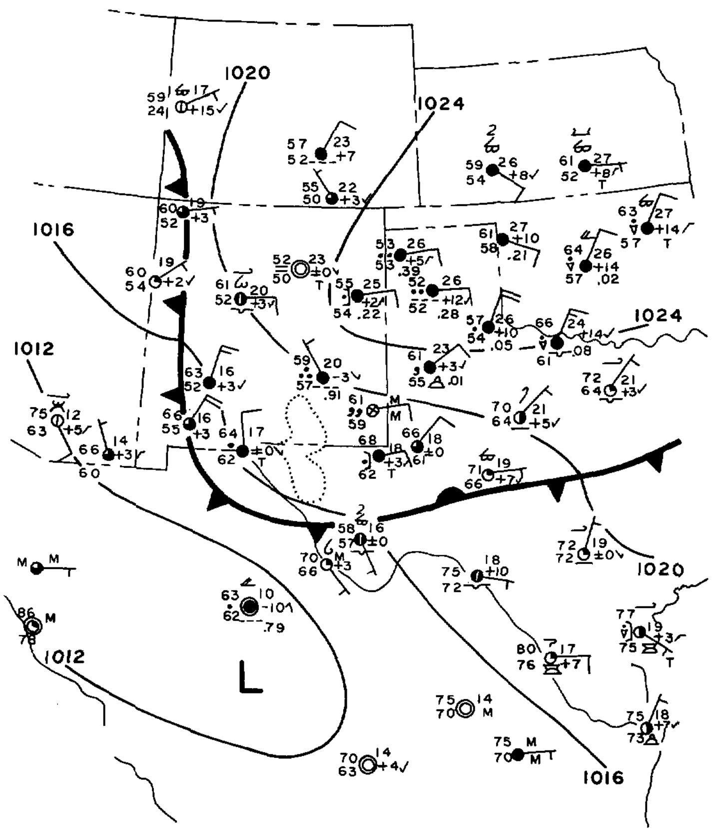

FIGURE 5.—Synoptic surface map for 0500 MST, August 23, 1966. Dotted line encircles storm area.

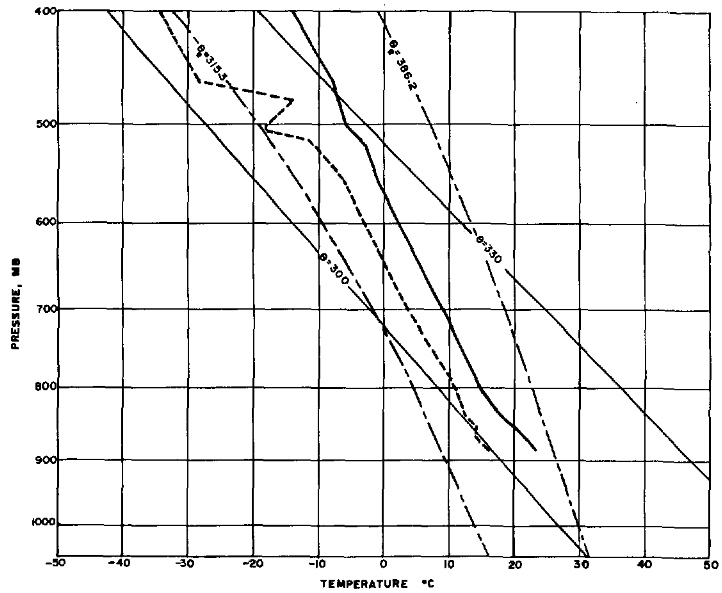

FIGURE 6.—Radiosonde observation for El Paso, Tex., 1700 MST, August 22, 1966; heavy solid line, air temperature; dashed line, dew point temperature.

3. CIRCULATION AT 700-MB. AND 200-MB. LEVELS AND ASSOCIATED DIVERGENCE PATTERNS

At 1700 MST, August 22, a well-defined trough at the 700-mb. level extended from near Clovis in eastern New Mexico across southwestern Texas to just west of Chihuahua, Mexico and southwestward to near Los Mochis, which is located on the eastern side of the Gulf of California at about 26° N. (fig. 7). Weak Lows were located near Chihuahua and over the Gulf of California just southwest of Los Mochis. By 0500 MST, August 23, the portion of the trough in the United States had moved farther westward (fig. 8) while the Low near Los Mochis had moved inland. The analysis over Mexico is based in part on available satellite photographs.

At the 200-mb. level an anticyclonic circulation prevailed over northern Mexico and much of the southwestern United States (figs. 9 and 10). Near the area of the heavy rains, the winds were generally 20 kt. or less.

The fields of horizontal convergence and divergence were calculated for the 700- and 200-mb. levels over a lattice grid with a 60 n. mi. spacing. The u and v components of the observed winds were first calculated and plotted, isotachs drawn, and values then interpolated to the grid points. Finally $\partial u/\partial x$ and $\partial v/\partial y$ were determined for each grid point and added to obtain the divergence at that location. The two levels have been superimposed for comparative purposes (fig. 11). Weak convergence existed at the 700-mb. level at 1700 MST, August 22 over the heavy rain area. This low-level convergence was surmounted by divergence at the 200-mb. level. By 0500 MST on the following morning (fig. 12), the pattern of low-level convergence had become more intense over southwestern Texas and extreme southeastern New Mexico

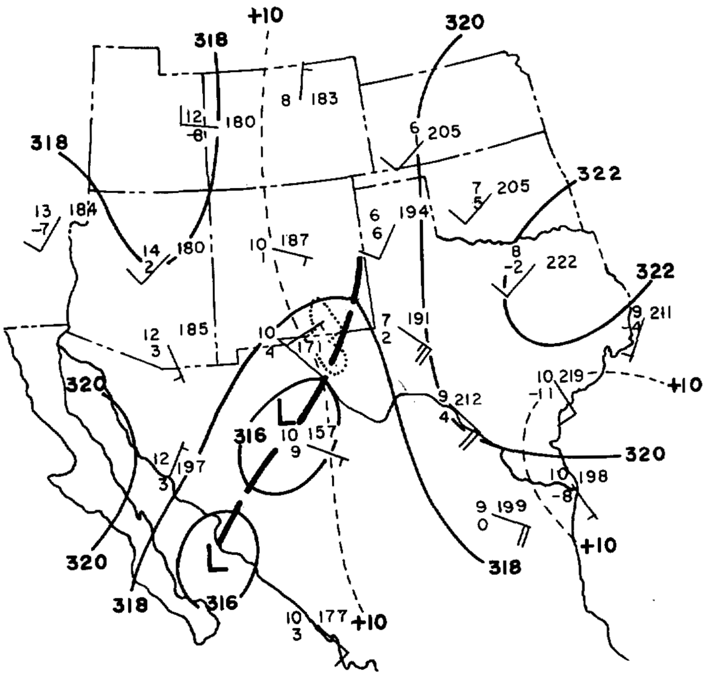

FIGURE 7.—700-mb. chart for 1700 MST, August 22, 1966; height contours (solid) in tens of meters, isotherms (dashed) in °C. Storm area encircled by dotted line.

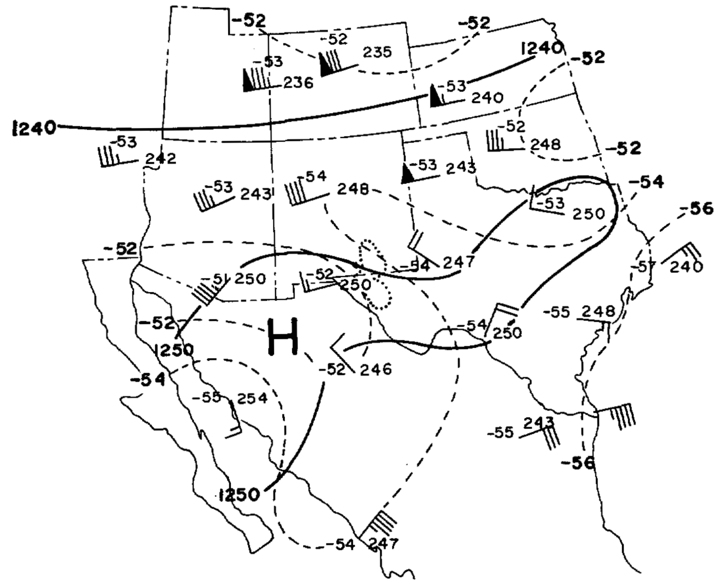

FIGURE 9.—200-mb. chart for 1700 MST, August 22, 1966.

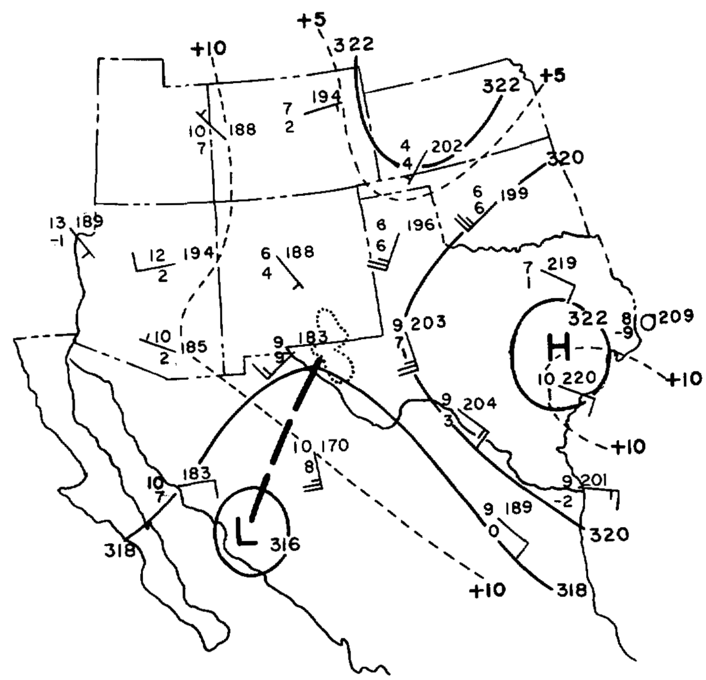

FIGURE 8.—700-mb. chart for 0500 MST, August 23, 1966.

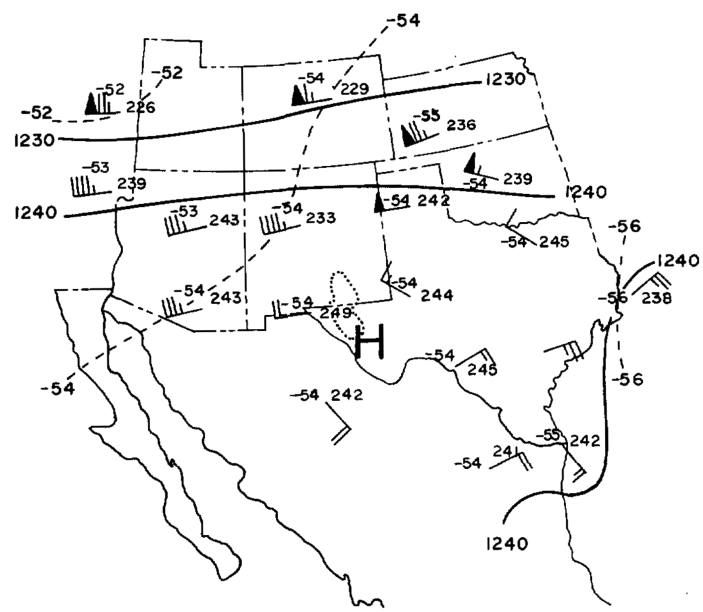

FIGURE 10.—200-mb. chart for 0500 MST, August 23, 1966.

while a transition from divergent to convergent flow was evident at the 200-mb. level.

The low-level convergence and high-level divergence associated with this storm resemble that connected with the heavy rains and flash flooding that nearly destroyed the town of Sanderson, Tex. on June 11, 1965 [3]. Sanderson is located in Terrell County in southwestern Texas about 30 mi. north of the Rio Grande River. The importance of these relationships to the problem of severe local storm forecasting has been discussed by other authors [4], [5]. Interestingly, most of the farmers and ranchers interviewed during a bucket survey in the Dell City, Tex. area reported that the extremely heavy rains which fell during the night of August 22 were accompanied by almost no wind and very little thunder or lightning.

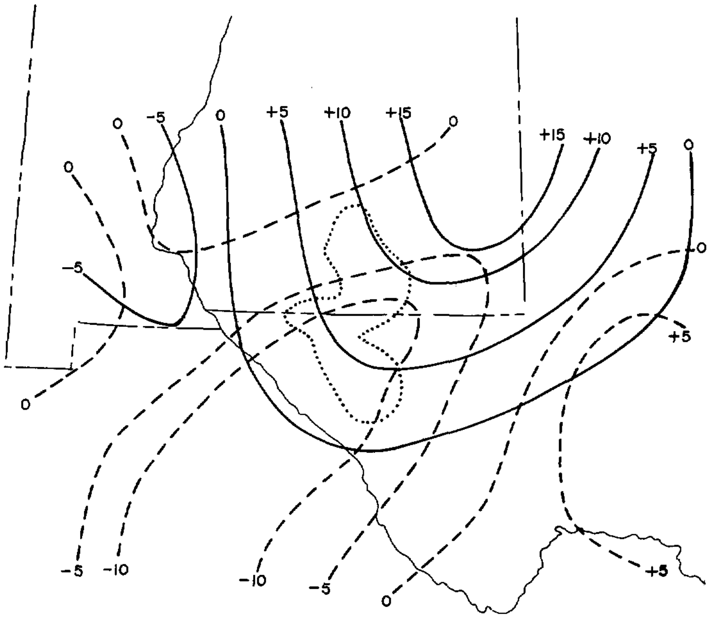

FIGURE 11.—Horizontal divergence analysis for 1700 MST, August 22, 1966, at 700 mb. (dashed line) and 200 mb. (solid). Units are 10^{-2} hr.$^{-1}$ Storm area is encircled by dotted line.

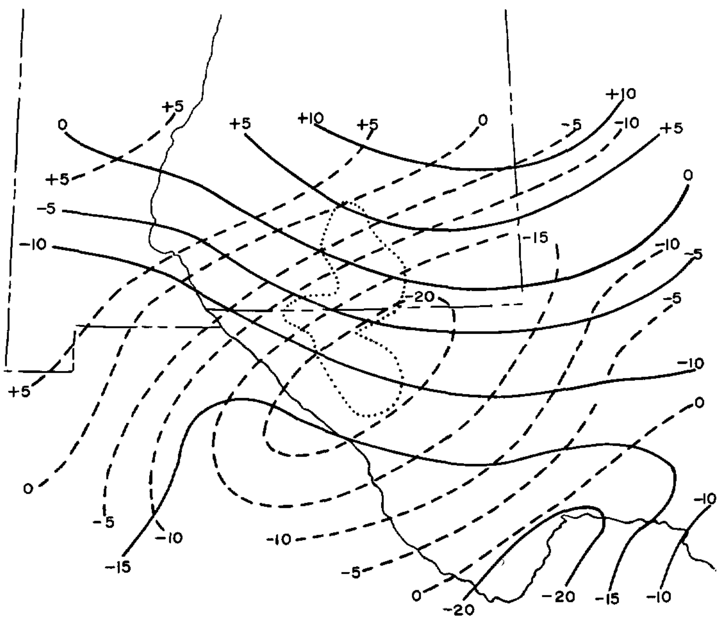

FIGURE 12.—Horizontal divergence analysis for 0500 MST, August 23, 1966.

4. VARIATIONS IN TROPOPAUSE TEMPERATURE AND PRESSURE

The well-developed upper-level cold Lows of the wintertime circulation frequently display a considerable vertical depth and are normally characterized by a lowering of the tropopause over the core of the Low [6]. In this case, the trough over the heavy rain area was quite distinct at the 700-mb. level (fig. 7) but had practically disappeared at the 500-mb. level, and at 200 mb. a distinct anticyclonic circulation was evident (fig. 9). An

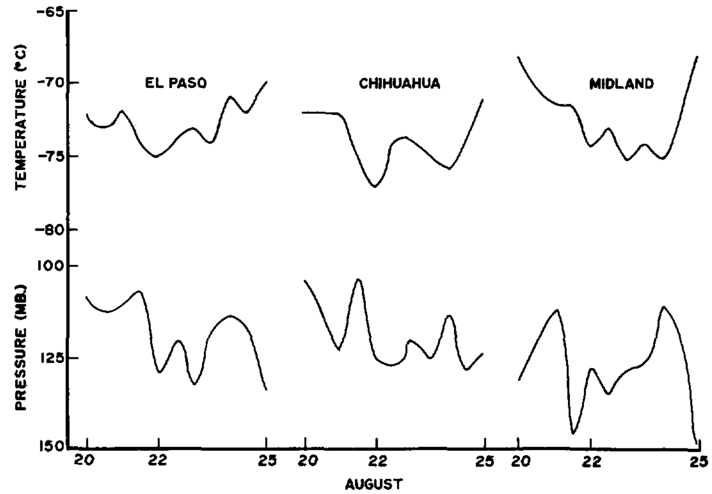

FIGURE 13.—Tropopause temperature (upper curves) and pressure (lower curves), August 20–25, 1966.

interesting variation in tropopause temperature and pressure accompanied these heavy rains (fig. 13). A cooling and lowering trend occurred at El Paso and Midland, Tex. and at Chihuahua, Mexico, preceding the onset of the heaviest rains. This was followed by warming and increasing heights as the heavy rains subsided. The net effect of such a cooling and lowering of the tropopause would be to decrease the thermodynamic stability of the air mass beneath it.

5. STRATOSPHERIC CIRCULATION

One of the most intriguing aspects of this storm is to be found in the stratospheric circulation over White Sands Missile Range, N. Mex. (located in the south-central part of the State) just preceding and during the heavy rains. Normally during August, a westward flow prevails in the stratosphere at these latitudes [7]. In this case, the zonal flow (fig. 14) from August 15 to 20 was westward as high as rocketsonde data were available with a maximum of a little over 70 m./sec. near 55 km. A striking change in this zonal flow occurred on August 21 and 22, with the 70-m./sec. winds at the 55-km. level decreasing to about 10 m./sec. This deceleration appeared at successively lower levels through August 25. Concurrent with this sharp decrease in the zonal flow was an increase in the meridional flow (fig. 15).

The relationships involved are obscure. Did the deceleration in the stratospheric flow influence the observed behavior of the tropopause and the triggering of the deluge? Conventional meteorological techniques offer no adequate explanation for rainfall of such intensity and duration. A relationship between oscillations in the wintertime stratopause zonal flow over the southwestern United States and the occurrence of cut-off Lows in that area has been reported by Jetton [8]. Perhaps some connection exists between waves in the summertime west-

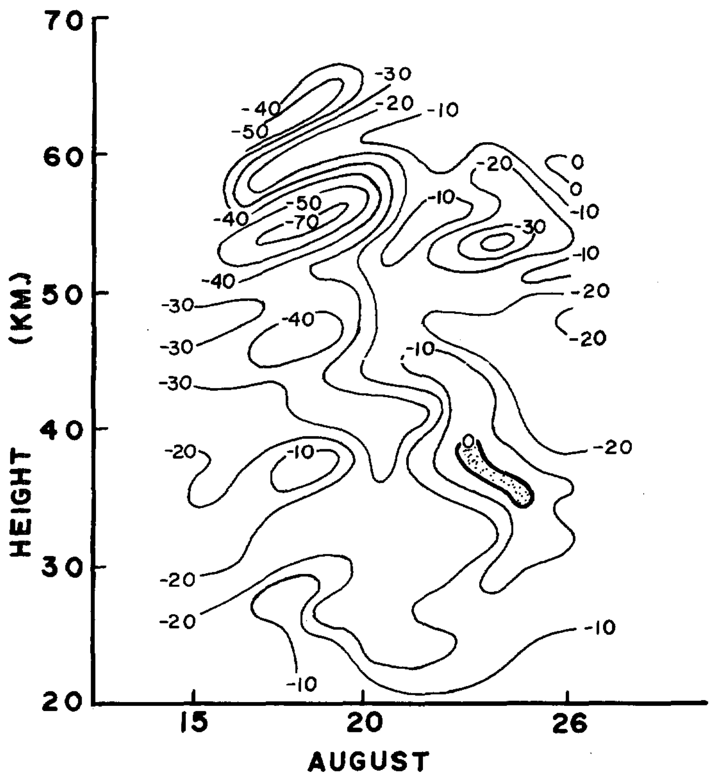

FIGURE 14.—Time section, zonal winds (m./sec.) for White Sands Missile Range, N. Mex., August 15–26, 1966; positive values indicate eastward flow, negative values westward flow.

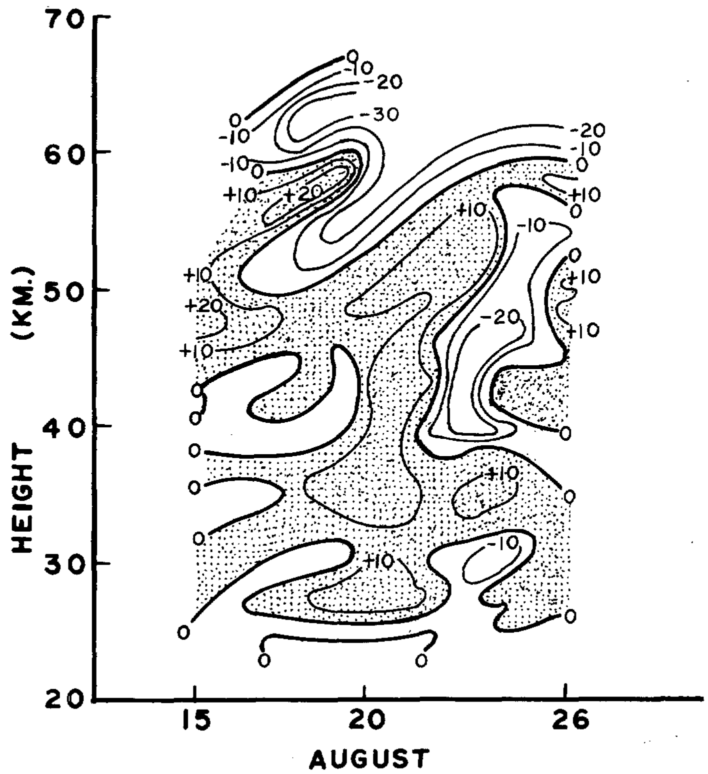

FIGURE 15.—Time section, meridional winds (m./sec.) for White Sands Missile Range, N. Mex., August 15–26, 1966; positive values indicate eastward flow, negative values westward flow.

ward flow of the stratosphere over the southwestern United States and the occurrence of record-breaking rains. At least it may be one of the many factors involved in the production of such cloudbursts.

6. SUMMARY

Preliminary to the heavy rains was the development of a confluent flow from the Gulf of Mexico and from the Pacific Ocean. This confluence zone extended northward across southwestern Texas and southeastern New Mexico. A cold front moving southward across the area along with the westward movement of a well-defined 700-mb. trough appear to have been additional contributing factors. Convergence existed at the 700-mb. level surmounted by divergence at the 200-mb. level just preceding the heaviest rainfall. This low-level convergence became more intense as the storm continued. Time sections of the stratospheric circulation over nearby White Sands Missile Range show that a wave in the westward stratopause flow moved across the area just prior to the onset of the heavy rains. This was accompanied by a lowering and cooling of the tropopause. This particular case suggests, at least, that variations in the stratospheric flow may play some role in the production of these rare but extremely heavy rains.

ACKNOWLEDGMENT

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